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Enhancing Children's Digital Literacy Through Schoology-Based Hybrid Project-Based Learning

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Abstract
This study aims to determine the effect of schoology-based hybrid project-based learning on digital literacy in children. This research is a type of quantitative research with a meta-analysis approach. The data of this study comes from the analysis of 25 studies obtained from ERIC, Sciencedirect, IEEE, Scopus and ProQuest. The inclusion criteria in the study are the research published in 2021-2024; SINTA or Scopus indexed research; Research should be relevant; The research data must be complete, and the sample size > 30 children. Data analysis with the help of JASP 0.19.30 application. The results of this study concluded that the average value of the summary effect size was (rRE = 0.989; Z = 8.213; $p < 0.001$). These findings show a positive influence of schoology-based hybrid project-based learning on digital literacy in children.

Keywords: *Project Based Learning; Schoology; Effect Size; Digital Literacy*

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Introduction

The development of technology in the world of education has brought significant changes in learning methods, especially with the emergence of various digital platforms and Learning Management Systems (LMS) that support interaction between educators and Children(Liu & Mu, 2022; Nurhayati et al., 2021). Digitalization in education allows the application of more flexible, interactive, and data-based learning methods, such as e-learning, blended learning, and hybrid learning (Harry Barton Essel et al., 2019). This innovation not only expands access to learning resources, but also increases the effectiveness of learning through features such as online discussions, automatic assignments, and more interesting multimedia integration (Deep et al., 2019). In addition, the use of technology in education is also in line with the concept of Society 5.0, where the use of artificial intelligence-based technology and the internet of things (IoT) increasingly emphasizes the importance of digital literacy in the learning process for children (Carhill-Poza, 2017).

In the 21st century, digital skills are an essential competency for Children to be able to adapt to increasingly digitized global dynamics(Riski Dwi et al., 2023). Digital literacy not only includes the ability to use technological devices but also includes a critical understanding of digital information, cybersecurity, and the ability to collaborate and communicate online. In the context of education, these skills are the basis for the development of higher-order thinking

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skills (HOTS) that support creativity, problem-solving, and innovation (Mohammad et al., 2023; Wantu et al., 2024; Luciana et al., 2024).

The issue of digital literacy in children is a major concern in the rapidly evolving technological era (Carhill-Poza & Williams, 2020). Digital literacy is not only the ability to operate technological devices, but also includes the ability to understand, evaluate, and use digital information critically and ethically (Atmojo & Nugroho, 2020). Children who lack digital literacy tend to be vulnerable to misinformation, harmful content, and cybersecurity threats, such as data theft and cyberbullying. In addition, limited understanding of ethics in the use of technology can also lead to negative behaviors, such as digital plagiarism or the dissemination of information without verification (Faga & Solomon, 2021; Febrianto et al., 2021). The gap in access to technology and the difference in the education level of parents and teachers in understanding the digital world are also factors that affect children's digital literacy skills. Therefore, there is a need for a systematic approach in education to increase awareness and digital literacy skills from an early age (Zulkifli et al., 2022; Oktarina et al., 2021).

The importance of digital literacy for children is increasing along with the integration of technology in the education system(Yustina et al., 2022; Durita Devy et al., 2023). Currently, digital-based learning, such as e-learning and hybrid learning, is increasingly being applied in schools. However, without an adequate understanding of digital literacy, children can have difficulty in filtering valid information and using technology productively. In addition, the lack of regulation and supervision of children's use of technology can also increase the risk of addiction to the internet and social media, which has an impact on mental health and decreases social skills in direct interactions (Yustina et al., 2022). Therefore, digital literacy education is not only the responsibility of schools, but must also involve the role of parents in accompanying and providing the right understanding of how to use technology wisely (Lockridge, 2019). Therefore, it is necessary to have a learning model that encourages digital literacy in children, namely through model Hybrid Project-Based Learning berbasis Schoology.

Hybrid Project-Based Learning combines project-based learning with a hybrid approach, which is a combination of online and offline learning, to create a more flexible and meaningful learning experience (Zulyusri et al., 2023; Uluk et al., 2024). In Hybrid PBL, Children are given the opportunity to explore, design, and complete projects based on real-world problems, utilizing digital technology as the main tool. This approach allows children to access a variety of digital resources, collaborate online through platforms such as Schoology, and develop critical thinking and problem-solving skills through face-to-face interactions (Negoro et al., 2023). The integration of technology in this model not only enriches the learning process but also helps children in developing digital skills, communication, and time management, which are essential competencies in today's digital era (Nugroho et al., 2022).

Hybrid PBL has great potential in improving Children' digital literacy because it requires them to actively use and understand various technologies in completing projects(Dewanto et al., 2023). By utilizing Schoology, Children can learn to manage information, filter credible sources, and use digital collaborative tools effectively. In addition, this method encourages Children to be more independent in accessing, evaluating, and presenting digital information, thereby improving digital literacy skills that include understanding technology, digital ethics, and cybersecurity (Farizi et al., 2019). In the context of offline learning, interaction with teachers and peers provides an opportunity to discuss their digital findings, enhance critical reflection, and connect digital concepts with real-world experiences. Thus, Hybrid PBL not only improves Children' digital literacy, but also develops 21st-century skills, such as creativity, collaboration, and communication, which are indispensable in facing future global challenges (Atmojo & Nugroho, 2020; Essel et al., 2019).

Research conducted by Bell (2010) shows that PBL can improve critical thinking and problem-solving skills, which are an important part of digital literacy. In addition, a study by Means et al. (2013) revealed that Hybrid Learning is more effective than conventional learning

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in improving Children' understanding of digital technology and information, as it allows them to flexibly access materials and interact with technology in a wider learning environment. However, these studies still discuss the two approaches separately without integrating them in one more comprehensive learning model. Stantchev et al. (2014) found that the use of LMS can improve student participation and skills in managing digital information, while a study by Aljawarneh (2020) suggests that Schoology can support project-based learning by providing effective collaboration and evaluation tools. Although this study highlights the benefits of using Schoology, there have not been many studies that specifically examine the effectiveness of Schoology-based Hybrid Project-Based Learning (Hybrid PBL) in improving Children's digital literacy.

Although various studies have examined the effectiveness of Project-Based Learning (PBL) and Hybrid Learning in improving 21st-century skills, there is still a gap in research that specifically explores the integration of the two in the form of Schoology-based Hybrid Project-Based Learning (Hybrid PBL) on children's digital literacy. Most of the existing studies have only highlighted the benefits of PBL in improving critical thinking, collaboration, and problem-solving skills, but not much has been discussed how this approach, when combined with an LMS like Schoology, can significantly affect children's digital literacy skills. Therefore, this meta-analysis research is needed to collect and analyze empirical evidence from various previous studies to provide a deeper understanding of the influence of this model on children's digital literacy. Based on this, this study aims to determine the influence of schoology-based hybrid project-based learning on digital literacy in children.

Methodology

This study uses a meta-analysis approach to determine the effect of schoology-based hybrid project-based learning on digital literacy in children. Meta-analysis is a research approach that evaluates previous research statistically to reach a conclusion (Tamur et al., 2020; Badawi et al., 2023; Nurtamam et al., 2023; Zulyusri et al., 2023). The meta-analysis research procedure is 1) determining the research inclusion criteria, 2) collecting data and coding, 3) analyzing the data statistically.

Eligibility Criteria

In the process of searching for data through the Google Scholar, ScienceDirect, Wiley, ERIC, ProQuest, Fronteins and Web of Science databases, the research must meet several inclusion criteria, namely study are the research published in 2021-2024; SINTA or Scopus indexed research; Research should be relevant; The research data must be complete and the sample size > 30 children. From the data search, 25 studies were obtained that met the inclusion criteria published in 2022-2024 which can be seen in Table 2.

Statistical Analysis

Data analysis in this study calculates the effect size value of each study analyzed. The effect size value in this study is to calculate the effect of schoology-based hybrid project-based learning on digital literacy in children. According to (Borenstein et al., 2007)Figure 1 shows the stages of data analysis in the meta-analysis. Furthermore, Table 1 shows the criteria for the effect size value in the study.

Table 1. Category Effect Size Value

Effect Size	Category
0.0≤ES≤ 0.2	Low
0.2≤ES≤ 0.8	Medium
ES≥ 0.8	High

Source: (Borenstein et al., 2007; Bachtiar et al., 2023; Tamur et al., 2020)

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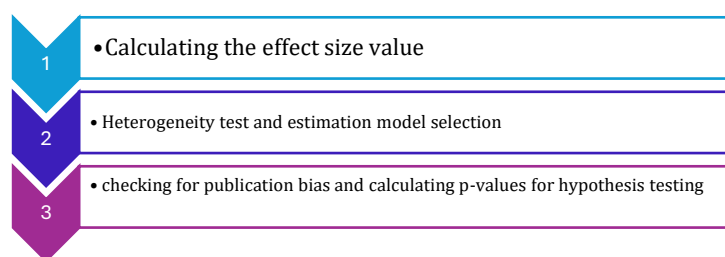
Figure 1. Data Analysis Procedure

Result and Discussion

Based on the results of a data search through the database, 25 studies/articles met the inclusion criteria. Table 2 shows the effect size and error standard.

Table 2. Effect Size and Standard Error Every Research

Code	Years	Effect Size	Standard Error	Variable
LK 1	2021	0.71	0.29	Digital Literacy
LK 2	2022	1.92	0.30	Digital Literacy
LK 3	2025	1.72	0.31	Digital Literacy
LK 4	2025	0.79	0.34	Digital Literacy
LK 5	2024	0.52	0.20	Digital Literacy
LK 6	2024	0.41	0.19	Digital Literacy
LK 7	2024	1.42	0.34	Digital Literacy
LK 8	2021	2.07	0.47	Digital Literacy
LK 9	2022	1.06	0.30	Digital Literacy
LK 10	2022	0.52	0.19	Digital Literacy
LK 11	2024	0.66	0.26	Digital Literacy
LK 12	2024	0.31	0.17	Digital Literacy
LK 13	2025	0.75	0.22	Digital Literacy
LK 14	2021	0.83	0.25	Digital Literacy
LK 15	2022	0.88	0.49	Digital Literacy
LK 16	2022	1.11	0.34	Digital Literacy
LK 17	2024	0.85	0.39	
LK 18	2025	1.97	0.51	Digital Literacy
LK 19	2022	2.99	0.42	Digital Literacy
LK 20	2021	0.80	0.35	Digital Literacy
LK 21	2021	0.83	0.12	Digital Literacy
LK 22	2022	1.48	0.33	Digital Literacy
LK 23	2024	0.97	0.40	Digital Literacy
LK 24	2024	0.33	0.13	Digital Literacy
LK 25	2021	0.49	0.29	Digital Literacy

Based on Table 2, the effect size value of the 25 studies ranged from 0.31 to 2.99. According to Borenstein et al., (2007) Of the 25 effect sizes, 11 studies had medium criteria effect sizes and 14 studies had high criteria effect size values. Furthermore, 25 studies were analyzed to determine an estimation model to calculate the mean effect size. The analysis of the fixed and random effect model estimation models can be seen in Table 3.

Table 3. Fixed and Random effect

	Q	df	p
Omnibus test of Coefficients Model	67.452	1	< 0.001
Test of Residual Heterogeneity	102.913	24	< 0.001

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Based on Table 3, a Q value of 102.913 was obtained higher than the value of 67. 452 with a coefficient interval of 95% and a p value of 0.001 <. The findings can be concluded that the value of 25 effect sizes analyzed is heterogeneously distributed. Therefore, the model used to calculate the mean effect size is a random effect model. Furthermore, checking publication bias through funnel plot analysis and Rosenthal fail safe N (FSN) test (Tamur et al., 2020; Badawi et al., 2022; Ichsan et al., 2023b; Borenstein et al., 2007). The results of checking publication bias with funnel plot can be seen in Figure 2.
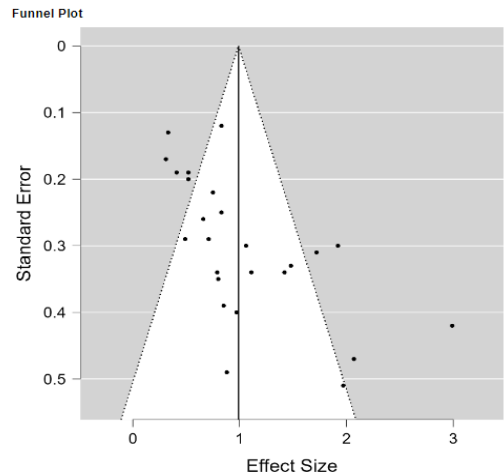
Figure 2. Funnel Plot

Based on Figure 2, the analysis of the funnel plot is not yet known whether it is symmetrical or asymmetrical, so it is necessary to conduct a Rosenthal Fail Safe N (FSN) test. The results of the Rosenthal Fail Safe N calculation can be seen in Table 4.

Tabel 4. Fail Safe N

File Drawer Analysis			
	Fail Safe N	Target Significance	Observed Significance
Rosenthal	2708	0.050	< 0.001

Based on Table 4, the Fail Safe N value of 2708 is greater than the value of 5k + 10 = 5(25) + 10 = 135, so it can be concluded that the analysis of 25 effect sizes in this data is not biased by publication and can be scientifically accounted for. Next, calculate the p-value to test the hypothesis through the random effect model. The results of the summary effect model analysis with the random effect model can be seen in Table 5.

Tabel 5. Mean Effect Size

Coefficient				
	Effect Size	Standard Error	z	p
Intercept	0.989	0.102	8.213	< 0.01

Table 5, the mean effect size value is obtained 0.989 with a standard error of 0.102. These findings explain the positive influence of schoology-based hybrid project-based learning on digital literacy in children compared to other conventional models with z = 8.213 and p < 0.001 in the high effect size category. These findings are in line with previous research that shows that PBL is an effective learning approach in developing various 21st century skills, including digital literacy (Mayer, 2004; Plass, 2009). The improvement of children' digital

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literacy in this study is reflected in their ability to access, evaluate, and create digital content. Children show significant improvements in their ability to use various software and applications to complete projects, as well as in searching for and evaluating information from various online sources (Essel et al., 2019;Negoro et al., 2023) . In addition, the online collaboration facilitated by Schoology also contributes to the development of children' digital communication skills (Elfira & Santosa, 2023).

The results of this study also show that the Schoology-based hybrid learning model can overcome several challenges in traditional learning. The flexibility of time and place in online learning allows children to learn at their own pace and according to their respective learning styles (Durita Devy et al., 2023). Additionally, the use of various online collaboration tools facilitates interaction between children and teachers, thus creating a more dynamic and engaging learning environment. Schools need to consider integrating PBL-based hybrid learning models into their curricula to equip children with comprehensive digital literacy skills (Dwi et al., 2023). In addition, teachers need to be provided with adequate training to be able to utilize technology effectively in supporting student learning (Ahern et al., 2019; Wu & Hyatt, 2016).

Conclusion

From the results of this meta-analysis, it can be concluded that the average value of the summary effect size is (rRE = 0.989; Z = 8.213; p <0.001). This finding indicates that there is a positive influence of hybrid project-based learning based on schoology on digital literacy in children. This learning model not only facilitates students' mastery of various software and applications, but also encourages them to think critically, collaborate, and communicate effectively in a digital environment. The implications of this finding are broad, ranging from education to policy. Schools can consider integrating hybrid PBL-based learning models into their curriculum to prepare students for challenges in the digital era. In addition, educational software developers can develop more tools and platforms that support project-based learning. For researchers, the results of this study open up opportunities to conduct further, more in-depth research on the factors that influence the successful implementation of hybrid learning models and their impact on various aspects of student development.

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